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## DEVICE FOR INTRODUCING A PREDETERMINED DOSE OF ADDITIVE INTO A PACKAGED LIQUID

1       An apparatus for introducing a predetermined dose of  
2       additive into a liquid

3

4       The invention relates to an apparatus for use with a  
5       container which automatically adds an additive in the  
6       form of a liquid or a pourable solid to a liquid in  
7       the container on opening of the container. In  
8       particular the invention relates to a dip tube  
9       apparatus located within the container, the dip tube  
10      containing the additive and being closed at one end  
11      by a valve and connected at the other end to a  
12      pressure source which automatically pushes the  
13      additive through the valve into the liquid in the  
14      container on opening of the container.

15

16      In a wide number of applications, such as  
17      pharmaceuticals for both human and animal use,  
18      agrochemicals and other more general applications it  
19      may be necessary to release and mix a liquid catalyst  
20      or reagent into a liquid before the liquid may be

1 used. In other applications, such as in the beverage  
2 industry, it may be desirable to add a component to a  
3 beverage immediately before consumption of the  
4 beverage, for example to effect a colour change, or  
5 to create a mixed beverage which has a limited  
6 storage life in the mixed state.

7

8 British Patent Application No 9823578 discloses an  
9 apparatus for introducing a component into a first  
10 liquid, the apparatus comprising a first container,  
11 such as a bottle, which holds the first liquid. The  
12 container has an opening closed by a releasable  
13 closure. A second container or tank containing  
14 pressurised propellant fluid is positioned in the  
15 neck of the first container, adjacent to the opening.  
16 A dip tube or conduit is attached to the tank, and  
17 has a first end communicating with the tank and a  
18 second end extending down into the first liquid in  
19 the first container. The dip tube contains an  
20 additive which is expelled from the dip tube into the  
21 first liquid by the entry of the propellant fluid  
22 from the tank into the conduit on release of the  
23 releasable closure.

24

25 The preferred form of dip tube is a polypropylene  
26 tube of circular cross-section, typically having an  
27 internal diameter of 5.8 mm. Such a tube has an  
28 internal capacity of 0.26 ml for each 10 mm length,  
29 so an 80 mm long tube can hold approximately 2 ml of  
30 product. The tank typically has a capacity of 2 ml,  
31 and contains pressurised propellant gas.

1

2 When the tank is of an impermeable material such as  
3 metal, then the headspace required for the propellant  
4 gas is only a proportion of the total tank volume,  
5 leaving the remainder of the tank volume as well as  
6 the tube volume available for product.

7

8 However when the tank is of a material such as  
9 plastic which exhibits long term permeability, then  
10 the headspace required for the propellant gas must be  
11 maximised, and none of the tank volume is available  
12 for product. The product must all be held in the  
13 tube. If a large volume of product is required it  
14 may be necessary to use larger diameter dip tubes  
15 capable of holding more product, and there is then a  
16 need for a valve arrangement at the lower end of the  
17 dip tube so that product does not drip or seep into  
18 the first liquid in the first container. The use of  
19 small diameter dip tubes such as capillary tubes  
20 avoids the need for valves, but such small diameter  
21 dip tubes can only hold a small amount of product.

22

23 Similarly if the product must be completely isolated  
24 from the first liquid in the first container there is  
25 a need for a valve arrangement at the lower end of  
26 the dip tube so that the first liquid cannot enter  
27 the dip tube by capillary action.

28

29 There is therefore a need for a dip tube apparatus  
30 which has a dip tube containing the additive and  
31 closed at one end by a valve, whereby the valve can

1    be readily opened when a pressure source pushes the  
2    additive through the valve out of the dip tube.

3

4    According to the present invention there is provided  
5    an apparatus for introducing an additive material  
6    into a first liquid, the apparatus comprising:  
7    a first container for holding the first liquid having  
8    an opening closed by a releasable closure,  
9    a second container positioned in the first container  
10   and containing propellant fluid at a pressure greater  
11   than atmospheric pressure, and  
12   a tubular conduit having a first end communicating  
13   with the second container and a second end  
14   communicating with the first container;  
15   wherein the conduit contains an additive material  
16   adapted to be expelled from the conduit into the  
17   first liquid by the entry of the propellant fluid  
18   into the conduit on release of the releasable  
19   closure;  
20   and wherein the conduit is provided with a first  
21   valve adjacent to its second end, the first valve  
22   being adapted to prevent the passage of said additive  
23   material into said liquid when the pressure in said  
24   conduit is equal to the pressure in said liquid, and  
25   the first valve being adapted to permit the passage  
26   of said additive material into said liquid when the  
27   pressure in said conduit is greater than the pressure  
28   in said liquid.

29

30    It is to be understood that the liquid may be a gel,  
31   a cream or a gel-like material.

1

2

3 In one embodiment the first container may be a bottle  
4 having a neck. The second container may be a tank or  
5 similar provided on the underside of the releasable  
6 closure. The conduit may extend below the surface of  
7 the first liquid in the bottle. Alternatively the  
8 conduit may extend to a position close to the wall of  
9 the first container above the surface of the first  
10 liquid, to avoid foaming of the liquid and the  
11 creation of pressure waves in the liquid.

12

13 In another embodiment the first container may be a  
14 can. The releasable closure may be a ring pull  
15 closure or other known closure suitable for use with  
16 a can. The can may have a cylindrical wall and two  
17 end walls, the closure being provided in one of the  
18 end walls. Preferably the second container is a tank  
19 attached to the inner surface of one of the end  
20 walls. Alternatively the second container may be  
21 freely suspended in the first liquid in the can.  
22 Preferably the propellant fluid is gas. Preferably  
23 the second container is placed in the can prior to  
24 filling of the can with the first liquid under a  
25 pressure greater than atmospheric pressure.

26

27 A second valve may be provided in the conduit  
28 adjacent to the first end of the conduit, the second  
29 valve being adapted to prevent the passage of said  
30 additive material into said second container, and the  
31 second valve being adapted to permit the passage of

1       said propellant fluid into said conduit when the  
2       pressure in said conduit is less than the pressure in  
3       said second container.

4

5       In one embodiment the conduit comprises a hollow  
6       tubular member of resilient plastics material, the  
7       first valve comprising a flattened end portion of the  
8       hollow tubular member, the flattened end portion  
9       comprising two opposing walls held in contact with  
10      each other by the resilience of the plastics material  
11      and adapted to move out of contact with each other  
12      when the hollow tubular member is subject to internal  
13      pressure to allow the passage of said additive  
14      material therethrough.

15

16      Preferably the flattened end portion is formed by  
17      applying heat to the tubular member. Preferably the  
18      heat is sufficient to cause plastic deformation of  
19      the material, but not sufficient to cause melt  
20      bonding of the opposing walls.

21

22      The two opposing walls may be substantially planar.  
23      Alternatively the two opposing walls may be arcuate  
24      in transverse section, the outer surface of a first  
25      one of the opposing walls being in contact with the  
26      inner surface of the second one of the opposing  
27      walls.

28

29      The flattened end portion may comprise one or more  
30      transverse folds. Alternatively the flattened end  
31      portion may be curved or bent about a transverse

1 axis. The flattened end portion may be rolled about  
2 a transverse axis.

3

4 Preferably the tubular member is of plastic, most  
5 preferably of polypropylene or HDPE. Preferably the  
6 tubular member is of circular cross-section.

7

8 In one embodiment the first valve comprises a plug  
9 means adapted to be ejected from the conduit when the  
10 pressure in said conduit is greater than the pressure  
11 in said liquid.

12

13 The second valve may also comprise a plug means  
14 adapted to be propelled along the conduit when the  
15 pressure in said conduit is greater than the pressure  
16 in said liquid, thereby causing the additive material  
17 to be ejected from the conduit.

18

19 The first valve may be any suitable valve means, such  
20 as a poppet valve or similar. The second valve may  
21 be any suitable valve means, such as a one way valve.

22

23 The conduit may contain a number of additives  
24 arranged at different positions along the length of  
25 the conduit. The additives are preferably liquid.  
26 However the additives may be provided in granule or  
27 powder form, preferably soluble. The additives may  
28 be colouring agents, flavouring agents, fragrances,  
29 pharmaceutical components, chemicals, nutrients,  
30 liquids containing gases in solution etc.

31

1 Examples of apparatus in accordance with the  
2 invention will now be described with reference to the  
3 accompanying drawings, in which:-  
4

5 Figs. 1(a) to 1(e) are cross-sectional views of  
6 a first embodiment of an apparatus of the  
7 invention, in which a container containing  
8 propellant fluid is integrally formed in a  
9 bottle top, showing the top before screwing on,  
10 during screwing on, screwed on tight, during  
11 release and fully removed respectively;  
12 Fig. 2 is a cross-sectional view of the  
13 embodiment of Fig. 1(a) to an enlarged scale;  
14 Fig. 3 is a longitudinal cross-sectional view  
15 through a first embodiment of a dip tube and  
16 valve of the invention in its closed state;  
17 Fig. 3a is a section on line X-X through the  
18 valve of Fig. 3;  
19 Fig. 4 is a longitudinal cross-sectional view  
20 through a second embodiment of a dip tube and  
21 valve of the invention in its closed state;  
22 Fig. 4a is a section on line Y-Y through the  
23 valve of Fig. 4;  
24 Figs. 5 to 7 are longitudinal cross-sectional  
25 views through third, fourth and fifth  
26 embodiments respectively of a dip tube and valve  
27 of the invention in its closed state; and  
28 Fig 8 is a cross-sectional view of a second  
29 embodiment of an apparatus of the invention, in  
30 which the first container holding the liquid is  
31 a can.

1  
2 Figs. 1(a) to 1(e) show an apparatus for  
3 automatically dispensing a product from a dip tube to  
4 a bottle or first container by means of pressurised  
5 propellant stored in a tank or second container when  
6 the top is removed from the bottle. The tank or  
7 second container is integrally formed with a screw  
8 top which is then screwed onto the bottle or first  
9 container, in the neck of which is secured an insert  
10 which has a rupturing spike and a dip tube.

11  
12 Fig. 1(a) shows a bottle 150 having an insert 100  
13 secured within the neck 160 of the bottle, shown in  
14 more detail in Fig. 2. The screw cap 152 is shown  
15 separately, before closure of the bottle 150. The  
16 cap 152 has an internal thread to mate with the  
17 external thread on the neck 160 of the bottle. The  
18 cap has an integrally moulded cylindrical portion  
19 which forms an inner container 111, which is closed  
20 at the upper end by a convex portion 112 of the cap  
21 152, so as to resist internal pressure in the inner  
22 container, and is open at the lower end 113. A  
23 circumferential groove 114 is provided externally at  
24 the lower end 113 of the inner container 111.

25  
26 A plastic ferrule 170 comprises an inner cylindrical  
27 wall 172 forming a chamber which is open at its lower  
28 end and closed by a foil seal or membrane 180 at its  
29 upper end. The inner cylindrical wall 172 is  
30 connected and sealed at its upper end to an outer  
31 cylindrical wall 174, whose outside diameter is

1 selected to fit tightly within the inside diameter of  
2 the inner container 111. At the lower end of the  
3 outer cylindrical wall 174 is provided a return  
4 flange 176 which has a circumferential rib 178  
5 adapted to cooperate with the groove 114 on the  
6 outside wall of the inner container 11. The inner  
7 wall 172 has upper and lower sealing ribs 182, 183  
8 which are adapted to provide a pressure resistant  
9 seal against the outer surface of the rupturing  
10 member 104.

11

12 The ferrule 170 is secured by a snap fit to the lower  
13 end 113 of the inner container 111, to provide a  
14 pressure resistant closure to the container. The  
15 inner container is filled with liquid 115 and  
16 pressurised gas 116 in a conventional fashion, so  
17 that the inner container is under internal pressure,  
18 causing the foil seal 180 to bow outwards.

19

20 An insert 100 is secured by any suitable means within  
21 the neck 160 of the bottle 150. The insert 100  
22 comprises a substantially cylindrical housing 101  
23 open at the upper end and having a number of legs 190  
24 projecting from the lower end. The housing is  
25 provided with detent members 191 which engage with  
26 the inside of the neck 160 of the bottle, so that the  
27 insert 100 cannot be readily removed. The upper end  
28 of the housing has a lip 102 which is adapted to  
29 engage with a recess 103 in the neck 160 of the  
30 bottle, to prevent the insert from being pushed down  
31 inside the neck.

1  
2 The legs 190 are connected at their lower end to a  
3 hollow spike member 104, which has a small diameter  
4 bore portion 105 at its upper end and a large  
5 diameter bore portion 106 at its lower end. Between  
6 the legs are apertures which allow the passage of  
7 liquid between the spike member 104 and the side of  
8 the bottle when the liquid is poured from the bottle.  
9 The number of legs and intervening apertures may be  
10 two, three, four or more as appropriate.

11  
12 Within the wall of the small diameter bore portion  
13 105 are provided a number of radial passages 108  
14 which communicate with the hollow interior of the  
15 spike 104 and the interior of the housing 101.  
16 Extending from the bottom of the hollow rupturing  
17 member 104 is a dip tube or conduit 130, surrounded  
18 by a plastic or sprung steel cone washer 109 which is  
19 secured to the rupturing member 104 and serves as a  
20 one-way retaining member to allow the conduit 130 to  
21 be inserted up into the large diameter bore 106 but  
22 to restrain it from being removed in a downwards  
23 direction. The large diameter bore portion 106 has  
24 an internal diameter equal to the external diameter  
25 of the dip tube 130. The step between the large and  
26 small diameter bore portions 105, 106 prevents the  
27 dip tube 30 extending into the small diameter bore  
28 portion 105 and blocking the radial apertures 108.

29

30 In use, the inner container 111 is filled with a  
31 liquid 115 and a pressurised gas 116 by means of

1 conventional technology used to fill pressurised  
2 dispenser packs, commonly known as aerosol  
3 containers. Alternatively the inner container 111  
4 may be filled solely with pressurised gas 116,  
5 omitting the liquid 115.

6

7 Fig. 1(b) shows the cap 152 while it is being screwed  
8 on to the neck 160. On application of the closure or  
9 cap 152 to the bottle 150, the inner container 111 is  
10 moved downwards and the spike 104 enters the space  
11 formed by the inner cylindrical wall 172 of the  
12 ferrule 170.

13

14 When the closure 152 is fully screwed tight on to the  
15 bottle 150, the inner container 111 moves to the  
16 position shown in Fig. 1(c), in which the seal member  
17 154 inside the cap 152 seals tightly against the top  
18 156 of the bottle neck 160. When this happens, the  
19 spike 104 bursts the rupturable membrane 180 and the  
20 member hollow spike extends into the inner container  
21 111. In this position the liquid 115 and gas 116 are  
22 prevented from escaping from the inner container 111  
23 by the ferrule 170 and spike member 104 which seal  
24 against each other to prevent release of the liquid  
25 115 and gas 116 from the container 111. The upper  
26 sealing rib 182 and lower sealing rib 183 formed  
27 inside the inner cylindrical wall 172 of the ferrule  
28 170 both seal against the outer surface of the spike  
29 member 104.

30

1 The inner container 111 remains in the position shown  
2 in Fig. 1(c) until a user releases the closure 152  
3 from the bottle 150. When this occurs, the inner  
4 container 111 moves to the position shown in Fig.  
5 1(d). In this position the upper sealing rib 182  
6 becomes unsealed from the spike member 104, but the  
7 lower sealing rib 183 remains in sealing contact with  
8 the outer surface of the spike member, below the  
9 apertures 108. This leaves an escape passage for the  
10 compressed liquid 115 (or gas 116), which is forced  
11 out of the container 111 by the pressurised gas 116  
12 in the direction of arrows 184, 185, 186, between the  
13 spike member 104 and ferrule 170, through the radial  
14 passages 108 and into the dip tube 130. The liquid  
15 115 or gas 116 then passes through the dip tube 130,  
16 expelling the concentrate or additive material 131  
17 from the dip tube 130 through the valve 300, shown  
18 schematically in Figs 1 and 2, into the liquid or  
19 other substance contained in the bottle 150. On  
20 removal of the closure 152, the inner container 111  
21 and ruptured ferrule 170 are removed from the bottle  
22 150 together, as shown in Fig. 1(e), leaving the  
23 insert 100 and dip tube 130 in the bottle. The  
24 insert does not impede pouring of the liquid in the  
25 bottle, which can flow between the support legs 190  
26 of the insert 100.

27

28 The dip tubes 130, typically thin-walled  
29 polypropylene tubes such as used in the manufacture  
30 of drinking straws or similar, may be of different  
31 diameter or length and may contain different

1 predetermined doses of additives. However the dip  
2 tubes may be larger diameter plastic tubes, holding  
3 for example 10ml of additive material. The tank 111  
4 may be only 2.5ml in volume, if pressurised to four  
5 or five times atmospheric pressure, so that on  
6 release of the closure 152 the propellant 116 expands  
7 to four or five times its volume, therefore expelling  
8 all the additive product 131 from the dip tube 130.

9

10 Figs 3 to 7 show five different embodiments of the  
11 valve 300 provided at the lower end of the dip tube  
12 130. In all cases the material 131 is held in the  
13 dip tube by the flattened end portion of the dip  
14 tube, and cannot exit from the dip tube until the dip  
15 tube is pressurised, causing the flattened end  
16 portion to open. The flattened end portion is formed  
17 by applying heat to the end of the dip tube 130. The  
18 heat is sufficient to cause plastic deformation of  
19 the material, but not sufficient to cause melt  
20 bonding of the opposing walls.

21

22 In the first embodiment of Fig. 3 the lower end of  
23 the dip tube 130 is provided with a flattened, duck  
24 bill shaped end portion 201. This arrangement  
25 requires a significant internal pressure before the  
26 valve will open, since the natural spring action of  
27 the inner wall 202 means it must "pop" open away from  
28 outer wall 203.

29

30 In the second embodiment of Fig. 4 the lower end of  
31 the dip tube 130 is provided with a simple, planar,

1 flattened end portion 211. The heating action means  
2 that the two walls 212, 213 are in equilibrium in the  
3 closed position.

4

5 In the third embodiment of Fig. 5 the flattened end  
6 portion 221 is folded back on itself, to provide a  
7 more secure closure. A high internal pressure is  
8 required, first to expand the upper portion 222 of  
9 the flattened end portion 221, and then to cause the  
10 fold 223 to straighten out, before the lower portion  
11 224 can expand. The heating action means that the  
12 fold 223 is in equilibrium in the folded position.

13

14 The fourth embodiment of Fig. 6 is similar to that  
15 shown in Fig. 5, except that there are three folds  
16 232 provided in the flattened end portion 231. Two  
17 or four or more folds may be provided if required.

18

19 In the fifth embodiment of Fig. 7 the flattened end  
20 portion 241 is rolled in a coil, which unrolls upon  
21 the application of internal pressure to the dip tube  
22 130.

23

24 Fig. 8 shows a partial view of a beverage can 500  
25 having a cylindrical side wall 502, a lower end wall  
26 504 and an upper end wall (not shown) which is  
27 provided with a conventional ring pull closure (not  
28 shown). Inside the can 500 a substantially  
29 impervious propellant container 510, which may be of  
30 metal or plastic, is secured to the inner surface of  
31 the end wall 504. The propellant container 510 has a

1       single large opening 512 at its upper side, as well  
2       as a very small diameter bleed hole 518 at its lower  
3       side, typically 0.3mm in diameter or less. Extending  
4       from the opening 512 is a dip tube or conduit 130,  
5       surrounded by a plastic or sprung steel cone washer  
6       514 which is secured to the rupturing member  
7       container 510 and serves as a one-way retaining  
8       member to allow the conduit 130 to be inserted into  
9       the opening 512 but to restrain it from being removed  
10      therefrom. Other methods of securing the dip tube  
11      130 to the propellant container 510 may be used, in  
12      place of washer 514.

13  
14      After the can 500 is filled with the beverage 540,  
15      liquid nitrogen is added to the beverage 540, the can  
16      500 is sealed and inverted. The headspace in the can  
17      reaches an equilibrium pressure  $P_f$  significantly  
18      higher than atmospheric pressure. This is a known  
19      technique with "widget" technology. Before filling  
20      the can with beverage, the unpressurised propellant  
21      container 510 and the dip tube, which contains  
22      additive product 131, are both attached to the bottom  
23      surface 504 of the can. The nitrogen gas in the  
24      headspace slowly enters the propellant container 510  
25      through the bleed hole 518 over a time of several  
26      minutes, until the interior of the propellant  
27      container reaches the higher pressure, so that the  
28      insides of the can and the container 510 remain at  
29      the higher equilibrium pressure  $P_f$ . The can may then  
30      be placed the correct way up again. When the can is  
31      opened by releasing the ring pull closure, the

1 pressure of the beverage in the can reverts to  
2 atmospheric pressure  $P_a$ . As a result of the pressure  
3 difference between the interior of the propellant  
4 container 510 and the interior of the can 500,  
5 propellant 516, in this case nitrogen gas, at  
6 pressure  $P_f$  is forced through the opening 512 and  
7 along the dip tube 130, forcing open the valve 300  
8 and expelling the concentrate or additive material  
9 131 from the dip tube 130 through the valve 300,  
10 shown schematically in Fig 8, into the beverage 540  
11 or other substance contained in the can 500. The  
12 path through the dip tube 130 represents a path of  
13 less resistance for the propellant 516 than through  
14 the bleed hole 518, because of the small size of the  
15 bleed hole 518.

16

17 To prevent additive 131 from passing into the  
18 propellant container 510, a second valve (not shown)  
19 may be provided in the portion 310 of the dip tube  
20 130 adjacent to the opening 512. This second valve  
21 may be any form of one way valve. Alternatively a  
22 readily rupturable membrane (not shown) may be  
23 provided at the opening 512 of the propellant  
24 container, which ruptures as soon as there is a  
25 greater pressure in the container 510 than outside.  
26 Alternatively a plug 520, shown in dotted outline in  
27 Fig. 8, such as a ball of glycerine or some inert  
28 gel-like substance, may be inserted in the portion  
29 310 of the dip tube 130 to prevent additive 131 from  
30 passing into the propellant container 510. The plug

1 520 is driven up through the dip tube under pressure  
2 from the propellant 516 on opening of the can 500.

3

4 It is envisaged that the dip tube valve arrangement  
5 may find other applications, and the invention is not  
6 be limited to use of the valve with the pressurised  
7 dispensing devices as shown in Figs 1(a) to 1(e) and  
8 Fig 8.

9

10 The invention can be used with fragrances,  
11 flavouring, pharmaceuticals (particularly suitable  
12 because of the accurate dosage obtainable),  
13 chemicals, vitamins etc. The tubes can be filled  
14 precisely at a different location and then inserted  
15 into the housing at the point of filling the bottles.  
16 Compressed air or other gas is particularly suitable  
17 as a propellant for powdered or granulated solids, so  
18 that liquid does not cause the solids to adhere to  
19 the side of the dip tube.

20

21 The dip tube valve of the invention is an inexpensive  
22 valve arrangement which prevents the product in a dip  
23 tube from leaking or dripping into the first liquid  
24 in the first container when the dip tube and first  
25 container are at the same pressure, but which allows  
26 the passage of liquid or pourable solid product from  
27 the dip tube into the first liquid in the first  
28 container when the dip tube is pressurised by  
29 introduction of the propellant fluid.

30

- 1 Modifications and improvements may be incorporated
- 2 without departing from the scope of the invention.